Fishery Data Series No. 91-67

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ABSTRACT

A postal questionnaire was distributed to 334 households to assess harvest characteristics of the Tanana River burbot *Lota lota* sport fishery in 1990. Burbot anglers were selected from three groups: 1) anglers who had previously responded to the Alaska Statewide Harvest Survey; 2) anglers who had provided tag returns or cooperated in other studies; and, 3) anglers from the Alaska Department of Fish and Game, and their families and friends. After two separate mailings, 257 (77%) questionnaires were successfully delivered, and 202 (80%) were completed and returned, of which 106 (41%) were from anglers who fished in 1990. No significant differences in responses were observed between mailings or among groups of respondents. Most harvest (78%) occurred during open water periods. Harvest was nearly equal among the two gear types (57% from hand-held lines and 43% from set-lines). More burbot were harvested in the middle river (73%) than in the upper (20%) or lower (7%) river. Ninety percent of the surveyed anglers fished with 10 set-line hooks or less per day of fishing and 50% fished with five hooks or less per day fishing. Most anglers surveyed (69%) caught only few burbot (1-5) during one day of fishing. Large daily catches of burbot (11-15) occurred on only 14% of the fishing days. Regulatory options to reduce harvest based on these findings are discussed.

KEY WORDS: burbot, *Lota lota*, questionnaire, angler, harvest, set-lines, hand-held lines, Tanana River, regulation.

INTRODUCTION

Burbot *Lota lota* are a sought-after sport fish by anglers in Alaska. The popularity of burbot fishing throughout interior Alaska increased dramatically in the early 1980's, with the largest annual harvest occurring in 1985 when over 27,000 burbot were taken from Alaskan waters (Mills 1986; Table 1). Conservation concerns brought on by increasing harvests, liberal regulations, and by the burbot's innate vulnerability to over-exploitation prompted the Alaska Board of Fisheries to implement more restrictive regulations governing seasons, daily bag and possession limits, and methods and means for many lacustrine fisheries.

The Tanana River (Figure 1) supports a substantial year-round burbot fishery yet still has a healthy population. Annual harvests have averaged about 24% of the total state-wide harvest over the past 12 years, and in recent years have comprised approximately 40% of the total burbot sport harvest in Alaska (Mills 1979-1990). Sport harvests have remained relatively stable since 1981 averaging 3,000-5,000 burbot annually (Table 1). The Tanana River is renowned for its trophy-sized burbot. Between 1967 and 1990, more certificates[1] were issued to anglers catching burbot in flowing waters of the Tanana River drainage than in all other areas of the state combined.

The Tanana River is of glacial origin flowing over 900 km and draining 44,500 square miles (Figure 2). The extremely turbid water of this river offer very limited angling for sight-feeding fish such as Arctic grayling *Thymallus arcticus* , northern pike *Esox lucius*, chinook salmon *Onchorhynchus tshawytcha*, and sheefish *Stenodus leucichthys*. As burbot feed primarily by olfactory cues, they are readily caught by passively fishing various types of bait. The upper and middle Tanana River is accessible year-round along most of its course from the Richardson and Parks Highways which parallel the river from the headwaters region near Northway downstream to Nenana. Many of the tributaries in this area are also accessible via various road systems. Access to the lower Tanana River can be accessed by road only at Nenana, Minto, and Manley.

The Division of Sport Fish of the Alaska Department of Fish and Game (ADFG) has been conducting research on burbot in the Tanana River since 1983. Because burbot migrate extensively throughout this system, burbot in the Tanana River should be considered a single stock for management of the fishery (Evenson 1989). Estimates of abundance and indices of abundance have been obtained for various river sections throughout the system and have indicated that annual exploitation does not exceed the sustainable yield of the population. Concerns are that the existing regulations could result in a substantial increase in harvest should the popularity (amount of fishing effort) of this fishery rise. This situation could result in localized depletions, lower fishing success by anglers, or fewer trophy-sized fish available to anglers.

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[1] Trophy Fish certificates are issued by the Alaska Department of Fish and Game for burbot officially weighing 3.63 kg (8 lbs) or more.

Table 1. Estimates of annual sport harvest of burbot in all Alaskan waters and in flowing waters of the Tanana River drainage, 1977-1990.

Year	Annual Harvest[a]		Proportion of Total State-Wide Harvest Taken From the Tanana River Drainage[b]
	Alaska	Tanana River Drainage[b]	
1977	8,425	1,542	0.18
1978	9,988	1,311	0.13
1979	7,304	1,827	0.25
1980	14,948	2,500	0.17
1981	14,342	3,611	0.25
1982	15,445	3,386	0.22
1983	14,465	4,306	0.30
1984	19,164	4,790	0.29
1985	27,230	4,515	0.18
1986	18,849	4,854	0.27
1987	13,543	3,789	0.28
1988	9,478	3,406	0.39
1989	9,268	4,225	0.46
1990	10,577	3,579	0.34

[a] Data from Mills (1978-1991).
[b] Considers only flowing waters of the Tanana River drainage.

Trophy-Sized Burbot Caught in Alaska 1967-1990

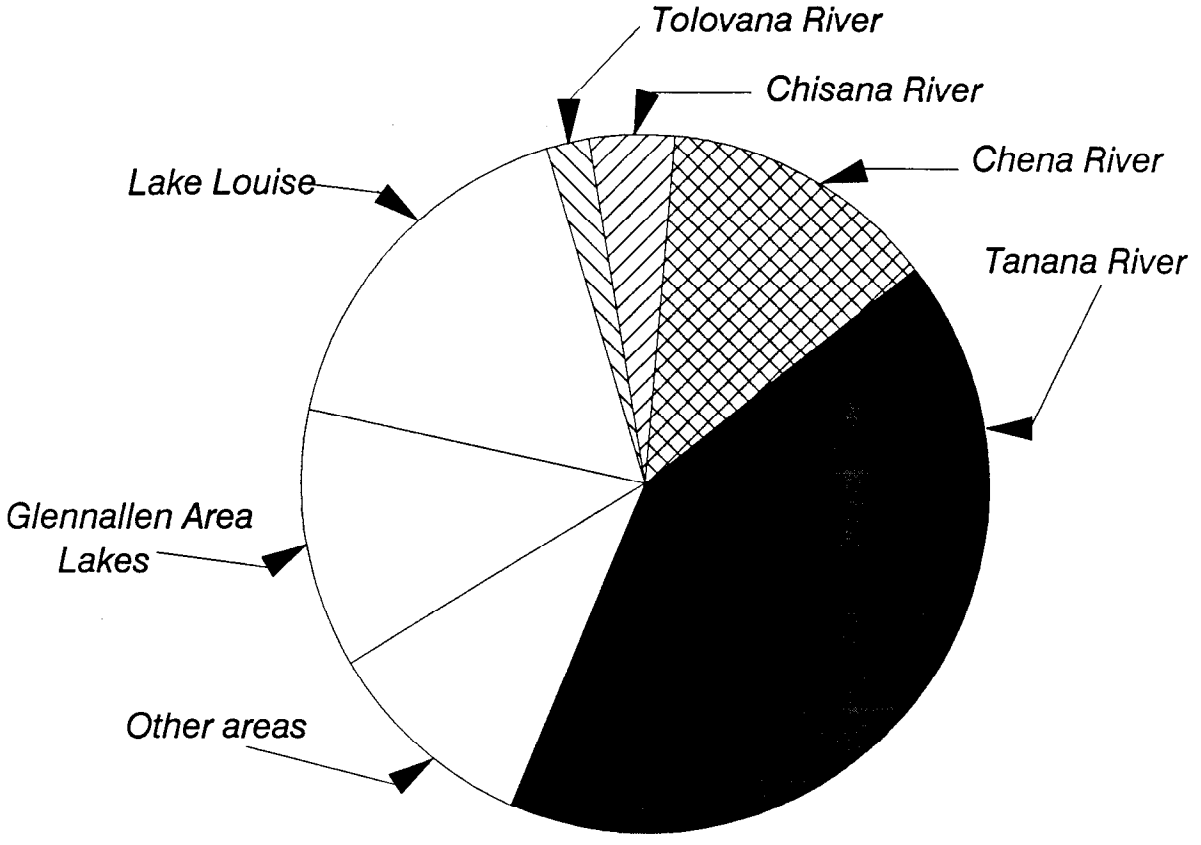

Figure 1. Proportions of trophy-sized burbot caught in flowing waters of the Tanana River drainage (shaded areas) and in other areas of Alaska.

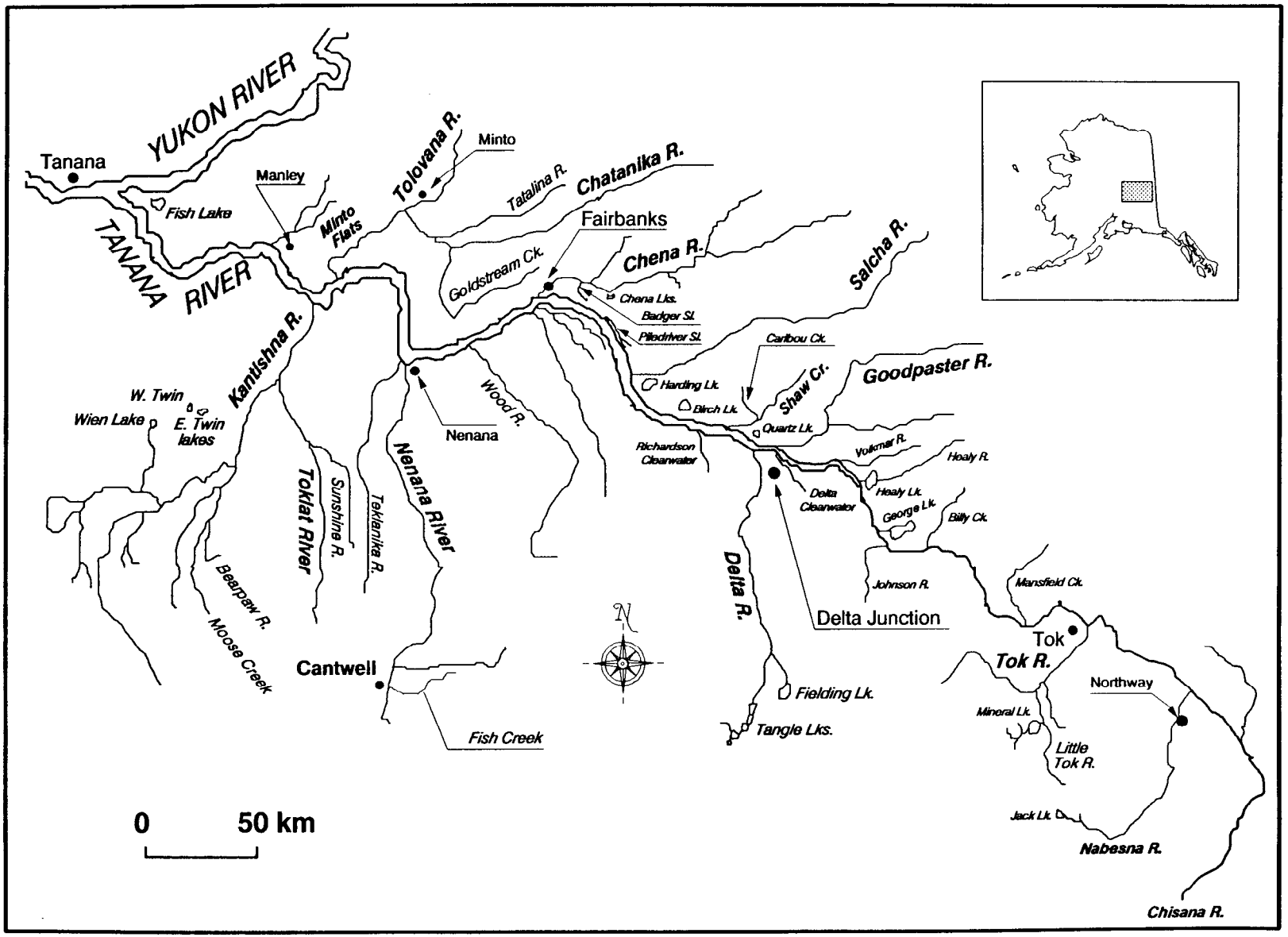

Figure 2. The Tanana River drainage.

FISHERY DESCRIPTION

Annual estimates of harvest throughout this system are obtained from an annual Alaska state-wide harvest survey (ASHS) consisting of repeated mailings of questionnaires to random samples of anglers who purchased a sport fishing license in Alaska that year. The survey, relative to burbot harvest in the Tanana River system, identifies harvest for three sections of the mainstream Tanana River ("upper", "middle", and "lower"), and for a number of tributaries. Most of the harvest in this system occurs in the middle Tanana River and lower Chena River (Fairbanks area), a moderate proportion in the upper Tanana River and its associated tributaries, while only a small proportion occurs in the lower Tanana River and its associated tributaries (Table 2).

A separate mail-out survey conducted by ADFG concerning opinions and regulatory preferences of anglers in the Tanana drainage showed that 16% of all license holders in urban and rural areas of the drainage fished for burbot during 1988 (Viavant and Clark 1990). Data from the ASHS (Mills pers. comm.[2]) indicated that most all respondents who fish for burbot in the Tanana River are resident to areas within the drainage.

Current regulations concerning the harvest of burbot in flowing waters of the Tanana River drainage allow a maximum of 15 fish a day in possession. These 15 fish may be taken with either baited set-lines (any combination of up to 15 hooks on set-lines may be used) or with hand held rod and reel, or both provided the total number of hooks does not exceed 15 per person per day. Set-lines are required to be checked once every 24 hours, but can be checked more frequently (thus, 15 burbot could be captured using fewer than 15 hooks).

The fishery occurs throughout the entire year, making use of both rod and reel and set-line gear. A concentrated (spatially and temporally) winter set-line fishery occurs primarily from mid October through mid January near Fairbanks. During this time anglers are concentrated. However, during other times of the year and in other areas throughout the drainage, fishing is spread out over time and over large areas, thus making it difficult and very labor-intensive to perform any kind of on-site creel census.

To better assess the characteristics of this fishery, a postal questionnaire was designed and was distributed to known burbot anglers resident throughout the drainage. The objectives of this questionnaire were to estimate:

1. the proportions of the harvest taken by gear (set-lines and hand-held, closely attended lines); by river section (upper, middle, and lower); and by season (open water and ice-cover);

2. the proportions of all angler days in which few (1-5), some (6-10), and many (11-15) set-line hooks were used; and,

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[2] Mills, Michael. 1990. Personal communication. ADFG, 333 Raspberry Rd., Anchorage, AK 99518-1599.

Table 2. Estimates of annual sport harvests of burbot in flowing waters of the Tanana River drainage, 1977-1990.

River	Annual Harvest[a] (Number of Burbot)													
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Mainstream Tanana River														
Lower Tanana[b]	0	0	0	0	0	0	0	0	0	0	40	218	130	236
Middle Tanana[b]	0	0	0	0	0	0	0	0	0	0	1,873	1,692	1,764	912
Upper Tanana[b]	0	0	0	0	0	0	0	0	0	0	409	509	411	641
Total Tanana[cd]	0	0	0	0	0	0	0	1,921	1,365	2,948	2,362	2,419	2,325	1,789
Lower Tanana River Tributaries														
Chatanika	34	18	9	50	5	42	21	13	175	40	13	55	10	17
Nenana[d]	0	0	0	0	0	0	0	0	0	0	53	0	60	68
Minto Flats	37	72	45	9	32	21	0	39	105	32	132	0	20	0
Middle Tanana River Tributaries														
Chena	642	389	807	1,127	1,317	1,457	1,055	1,233	2,065	889	149	386	1,322	304
Salcha	0	0	0	0	0	0	0	0	35	296	0	18	0	203
Piledriver Slough[d]	0	0	0	0	0	0	84	0	0	0	79	55	100	456
Shaw Creek[d]	0	0	0	0	0	0	0	415	175	120	607	0	170	354
Upper Tanana River Tributaries														
Delta Clearwater	0	0	0	29	0	0	0	13	0	0	26	0	0	0
Goodpaster[d]	0	0	0	0	0	0	0	221	350	88	13	109	120	0
Other Areas[e]	829	832	966	1,285	2,257	1,866	3,146	935	245	441	355	364	100	388
Total	1,542	1,311	1,827	2,500	3,611	3,386	4,306	4,790	4,515	4,854	3,789	3,406	4,225	3,579

[a] Data from Alaska statewide harvest survey (Mills 1978-1991).
[b] River sections were not described as specific areas on the survey form until 1986.
[c] Includes harvests from upper, middle, lower, and unspecified sections.
[d] Was not described as a specific area on the survey until 1984. Any harvest that may have occurred in this area would have been listed in the "Other Areas" category.
[e] Was described as "other waters" on the survey form until 1984, and may have included harvest from lakes and ponds. Beginning in 1984, was described as "other streams" on the survey form.

3. the proportions of daily catches in which few (1-5), some (6-10), and many (11-15) burbot were caught using both set-lines and hand-held lines during both open-water and ice-cover seasons.

METHODS

Survey Description

The survey consisted of 12 questions related to burbot fishing in flowing waters of the Tanana River drainage. All of the questions in the survey pertained to burbot fishing taking place in 1990 only. The questionnaire was composed of three parts (Appendix A). Part one (pages 3,4) concerned hand-held (rod and reel) gear, part two (pages 5,6) concerned set-line gear, and part three was comprised of general questions regarding opinions and preferences. Information on opinions and preferences were not analyzed for this report. Questions relating to the first objective (proportions of catch by gear type, area, and season) required the respondent to report the total number of burbot harvested within each category. The Tanana River system was divided into three areas (described in the questionnaire). These areas were chosen because they correspond to the areas used in the ASHS. The areas correspond to the lower, middle, and upper portions of the drainage, and are hereafter referred to as river areas I, II, and III, respectively. Seasons were divided into open-water or ice-cover and were selected for ease of recall by respondents. The categories (few, some, or many) for the distribution of the number set-line hooks used (objective 2) and distribution of daily catches (objective 3) were also selected for ease of recall by the respondent. Because of the potential bias associated with nonresponse in survey sampling, attempts to minimize nonresponse were made as suggested by Linsky (1975). First, the questions were kept simple. Second, a cover letter (Appendix B) was attached to request cooperation and to explain the purpose of the study. Third, a stamped, self addressed return envelope was included with each questionnaire. And fourth, a second mailing of letters (Appendix B) and questionnaires was sent to all initial nonrespondents one month after the first mailing.

Sampling Units

Five hundred twenty-five surveys were distributed to 334 households selected from households that contained people who 1) responded to the ASHS as having fished for burbot between 1984 and 1989 (443 surveys to 238 different households), 2) people who in the past two years had returned tags and or fish samples for other burbot studies (one survey to 70 households), and 3) staff, their families and friends who were known burbot fishermen (one or more surveys to 26 households). Most surveys were mailed on 7 February, 1991 with the balance (65 surveys) mailed on 11 April, 1991. This last batch was sent to respondents to the ASHS in 1987 and 1988.

A problem inherent with all survey sampling is the effects of nonrespondents on the parameters being estimated. Analysis of nonresponse bias from ASHS (Mills pers. comm[2]) indicated that nonrespondents tended to fish less and catch fewer fish than did respondents. In this case, a correction factor was

applied to the parameter computed from the respondents. The correction factor was determined by examining the trend in responses from multiple mailings. Typically, the largest difference in response was noted between the first and second mailings. To determine the effects of nonresponse on this study, a second mailing of the same questionnaire was sent approximately one month later to all initial nonrespondents. The various parameters were computed from each mailing and were compared for significant differences.

This survey also has the added source of potential bias in that it was not a random sample. While the ASHS is a random sample of licensed anglers in the state of Alaska, the recipients of the survey had to have cooperated with or have been associated with the ADFG in the past. As stated above, respondents usually tend to fish more and catch more fish than nonrespondents. This could also bias the results of this survey. This bias will only be present if those fishermen who fish more and catch more fish do so because of higher catch rates for a given unit of effort. This bias should only affect proportion estimates for the third objective (the proportion of daily catches in which few, some, or many burbot were caught). To test for this bias, first all parameters were estimated from each mailing source and compared for significant differences. Second, an overall harvest estimate of burbot from the Tanana River was calculated from this survey and compared to the estimate from the ASHS for 1990.

The assumption is made however that while the total harvest estimated from this survey may be biased, the estimated proportions of how, when, and where burbot were caught are not biased. Proportions of harvest by river area estimated from this study and from the ASHS were compared. While there is no test with data from this survey, it does not seem logical that gear type used or season fished would have an influence on response rates.

Data Analysis

In this investigation each parameter Θ is an estimator of a cluster proportion of the general form described by Cochran (1977):

$$\hat{\Theta}_j = \frac{\sum_{i=1}^{n} a_{ij}}{\sum_{i=1}^{n} m_i} \qquad (1)$$

$$\hat{V}(\Theta_j) = \frac{\sum a^2_{ij} - 2\hat{\Theta}_j \sum a_{ij}m_i + \hat{\Theta}^2_j \sum m^2_i}{n(n-1)\left(\frac{m_i}{n}\right)} \qquad (2)$$

where:

$\hat{\theta}_j$ = the estimated proportion of category j (gear type or season or area or number of hooks or number of days);

a_{ij} = the number of elements (fish or days) from angler i that belong to category j;

m_i = the number of elements from anglers i; and,

n = the number of anglers in the sample.

Ninety-five percent confidence intervals were calculated for each parameter from each mailing and from each source. Values were then compared between mailings and between sources to determine if the data could be pooled, and to determine if there was significant bias in θ from nonresponse to the survey.

RESULTS

Of the 334 survey packets mailed, 257 (77%) were successfully delivered, 202 (80%) were completed and returned, and 106 (41% of delivered surveys) responded as having fished for burbot in 1990 (Table 3). Most responses and the lowest delivery and return rates came from individuals responding to the ASHS in previous years. Response rates from the 1989 and 1988 ASHS mailing list were higher than other mailing years comprising this list. Of the 48 surveys mailed to military bases located in Alaska, 36 (75%) were returned undelivered.

Only one parameter (number of days fished in open water when many fish were caught) in 19 was different when responses from the two mailings were compared (Appendix C1). Since this is in the range of random variation ($\alpha = 0.05$), the data from both mailings was pooled. Each test had the ability to detect a difference of 0.35 with the probabilities of type I and type II errors being 0.05 and 0.20 respectively. While these tests were not particularly sensitive, only one in 19 failed and in that failure the second mailing had a higher catch rate.

Comparison of statistics among sources of subjects showed no significant differences between sources for any of the 19 parameters (Appendix C2). Each test had the ability to detect a difference of 0.35 with the probabilities of type I and type II errors being 0.05 and 0.20 respectively. The data from all sources and all mailings were pooled.

Estimated harvest in 1990 from the ASHS was 3,579 burbot (SE = 829), and was substantially lower than the estimated harvest of 19,760 from this survey. Anglers surveyed in the ASHS went on an estimated 7,765 fishing trips in 1990, while anglers surveyed in this study went on an estimated 13,000 trips. Thus, respondents from this survey fished more often (1.7 times as many trips) than did respondents to the ASHS, and had a higher catch rate (caught 3.3 times as many burbot).

Table 3. Response rates by mailing source to the postal questionnaire.

Survey Source	Number Surveys Mailed[a]	Number Un-Delivered	Number of Military Un-Delivered	Total Delivered	Response First Mailing	Response Second Mailing	Total Response	Total Non-Response	Number of Respondents who Fished in 1990
ASHS (1984)	35	19	15	16	6	3	9	7	4
% of Mailed		54	43	46	17	9	26	20	11
% of Delivered					38	19	56	44	25
ASHS (1985)	29	10	7	19	10	5	15	4	2
% of Mailed		34	24	66	34	17	52	14	7
% of Delivered					53	26	79	21	11
ASHS (1986)	52	20	11	32	15	8	23	9	7
% of Mailed		38	21	62	29	15	44	17	13
% of Delivered					47	25	72	28	22
ASHS (1987)	39	12	1	27	15	3	18	9	5
% of Mailed		31	3	69	38	8	46	23	13
% of Delivered					56	11	67	33	19
ASHS (1988)	26	5	2	21	12	3	15	6	8
% of Mailed		19	8	81	46	12	58	23	31
% of Delivered					57	14	71	29	38
ASHS (1989)	53	2	0	51	31	17	48	3	22
% of Mailed		4	0	96	58	32	91	6	41
% of Delivered					61	33	94	6	43
ASHS (All)	238	68	36	170	89	39	128	42	48
% of Mailed		29	15	71	37	16	54	18	20
% of Delivered					54	23	77	25	28
Sport Fish	70	9		61	33	17	49	11	33
% of Mailed		13		87	47	24	70	16	47
% of Delivered					55	28	82	18	54
ADFG	26	0		26	23	2	25	1	25
% of Mailed		0		100	88	8	96	4	96
% of Delivered					88	8	96	4	96
Total	334	77		257	145	58	202	54	106
% of Mailed		23		77	43	17	60	16	32
% of Delivered					58	23	80	21	41

[a] Indicates the number of households surveyed. A household may have received more than one survey.

Proportions of Harvest

Hand-held gear fished during open water periods in river area II comprised the largest proportion (0.404) of the harvest in 1990, while hand-held gear fished during ice-cover periods in river areas I and III (0.003 and 0.002 respectively) and set-lines fished during ice cover (0.002) in area I comprised the lowest proportions. Set-lines fished during ice-cover in river area II, and set-lines during open water in river area II contributed the next highest proportions of total harvest (0.189 and 0.129 respectively; Table 4).

Gear:

Near equal proportions of fishing effort were expended by anglers using the two gears. Twenty-eight percent of the anglers surveyed used only set-lines, 40% used only hand-held lines, and 32% used both gear (Figure 3). Anglers spent an average of 8 days in 1990 fishing with set-lines, 7 days fishing with hand-held lines, and 10 days in 1990 fishing with both gear (Figure 4). The average harvest per angler in 1990 was 11 burbot using set-lines, 13 burbot using hand-held lines, and 15 burbot using both gear types (Figure 5). Overall, hand-held gear was used to harvest slightly more burbot (57%) during 1990 than was harvested with set-lines (43%). Of the total hand-held harvest, nearly all (98%) was from open water periods, and 71% was from river area II. Of the harvest with set-lines, nearly equal proportions were from open water (52%) and ice cover (48%) periods. River area II comprised 75% of the total set-line harvest (Figure 6).

River Area:

In 1990, 73% of the harvest came from area II, 20% from area III, and 7% from area I. This compares to estimates of 10%, 70% and 20% for river areas I, II, and III respectively from the 1990 ASHS (Mills 1991). In river area I, nearly all burbot (91%) were harvested with hand-held lines. In river areas II and III, the proportions of total harvest within each area were nearly equal for set-lines and hand-held lines. In all three river areas, markedly more burbot were harvested in open water periods than in ice-cover periods (Figure 7).

Season:

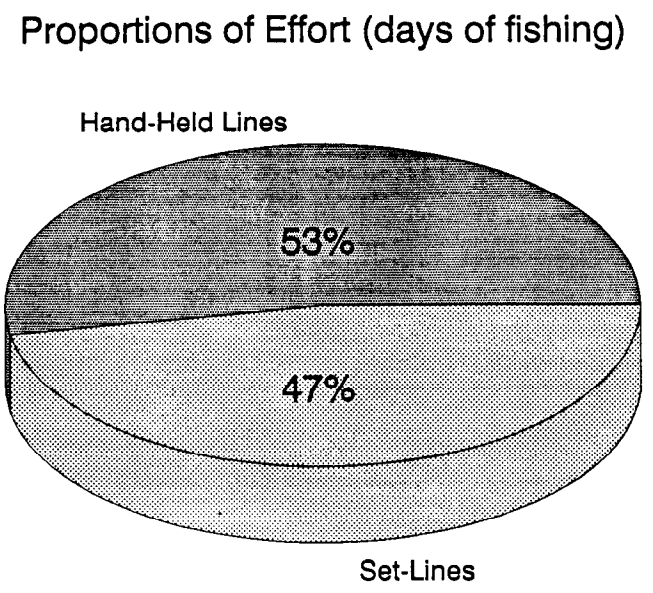
Seventy-eight percent of the total harvest in 1990 was taken during periods of open water. During this period, 73% of the harvest was with hand-held gear. The highest proportion of the harvest during open water was from river area II (68%), while areas I and III accounted for only 8% and 24% of the total harvest respectively. During the ice-cover period, nearly all the harvest (94%) was taken with set-lines, and nearly all the harvest was taken from river area II (Figure 8).

Proportions of Set-Line Effort

During all times of the year (ice-cover and open water), 90% of the surveyed anglers fished with 10 hooks or less per day, and about half of the anglers (43% during ice-cover and 57% during open water) fished with five hooks or less per day. Anglers tended to use 11 hooks or more (per day) more often

Table 4. Proportions of the total sport harvest of burbot in the Tanana River drainage by gear type, river area, and season.

Gear Type	River Area	Season	Number of Respondents	Reported Harvest (Burbot)	Proportion of Total Harvest	SE
Hand-Held	I	Ice-Cover	2	5	0.003	0.002
Hand-Held	I	Open-Water	9	105	0.061	0.031
Hand-Held	II	Ice-Cover	3	13	0.008	0.006
Hand-Held	II	Open-Water	43	697	0.404	0.062
Hand-Held	III	Ice-Cover	1	4	0.002	0.002
Hand-Held	III	Open-Water	19	171	0.099	0.030
Set-Line	I	Ice-Cover	1	3	0.002	0.002
Set-Line	I	Open-Water	2	8	0.005	0.003
Set-Line	II	Ice-Cover	27	326	0.189	0.049
Set-Line	II	Open-Water	19	222	0.129	0.036
Set-Line	III	Ice-Cover	4	25	0.014	0.009
Set-Line	III	Open-Water	13	146	0.085	0.038
		Total	100	1,725	1.000	



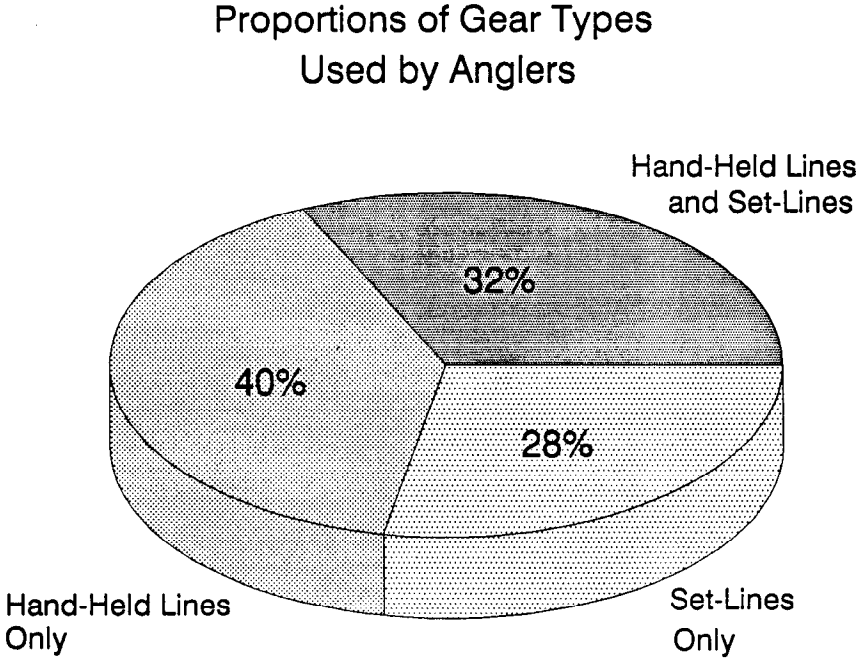


Figure 3. Proportions of gear types used by anglers to catch burbot.

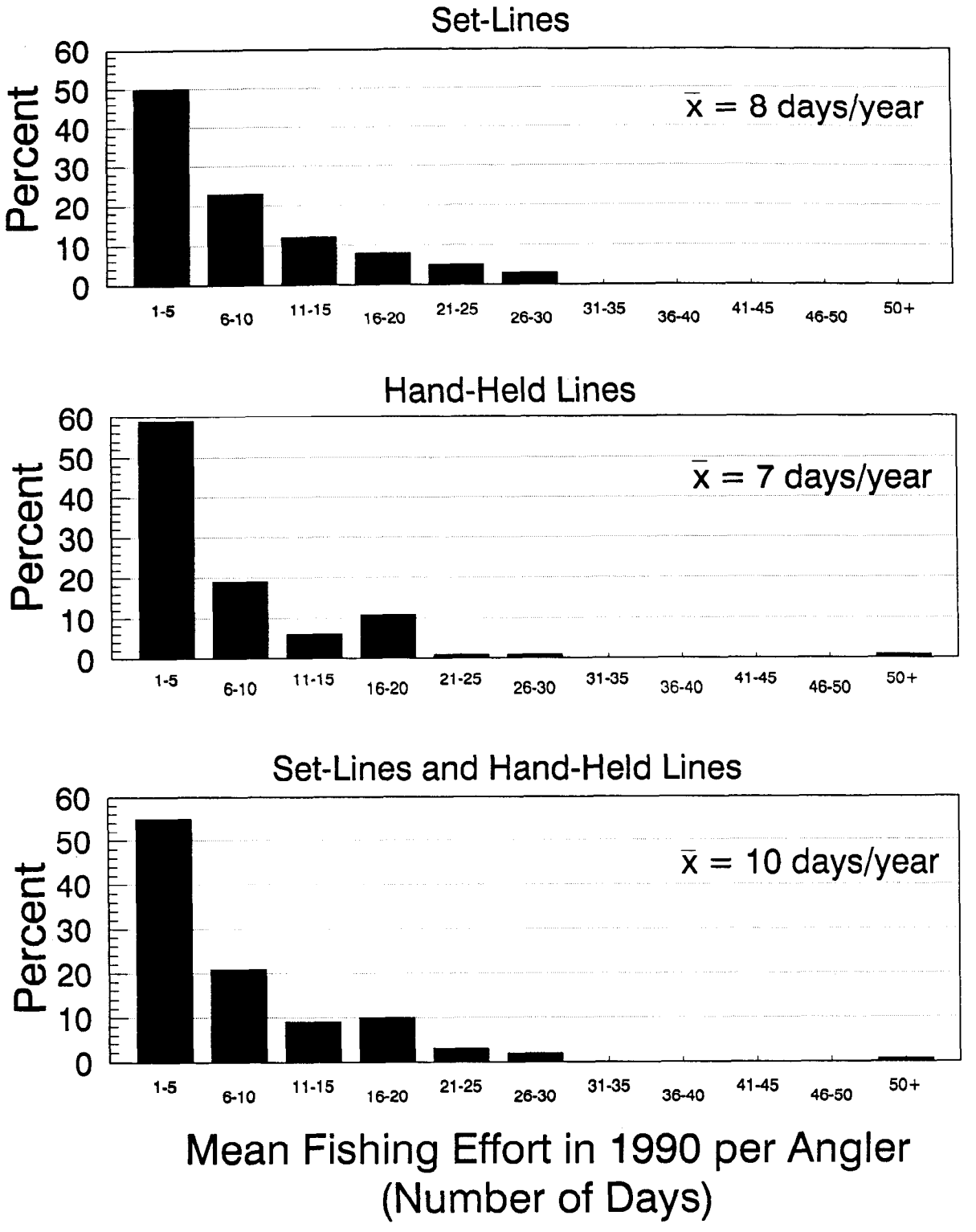


Figure 4. Mean annual effort per angler using set-lines and hand-held lines.

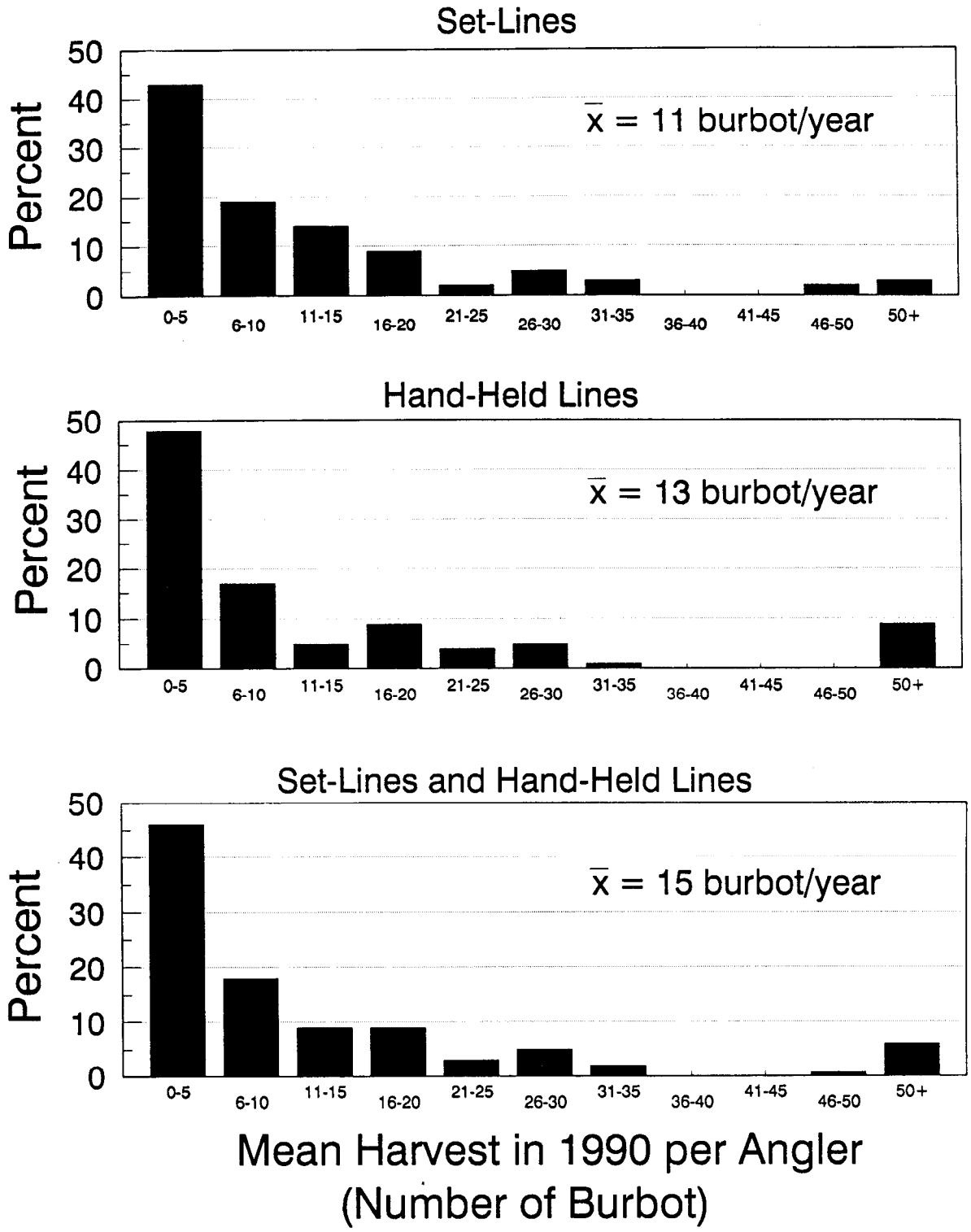


Figure 5. Mean annual harvest of burbot per angler using set-lines and hand-held lines.

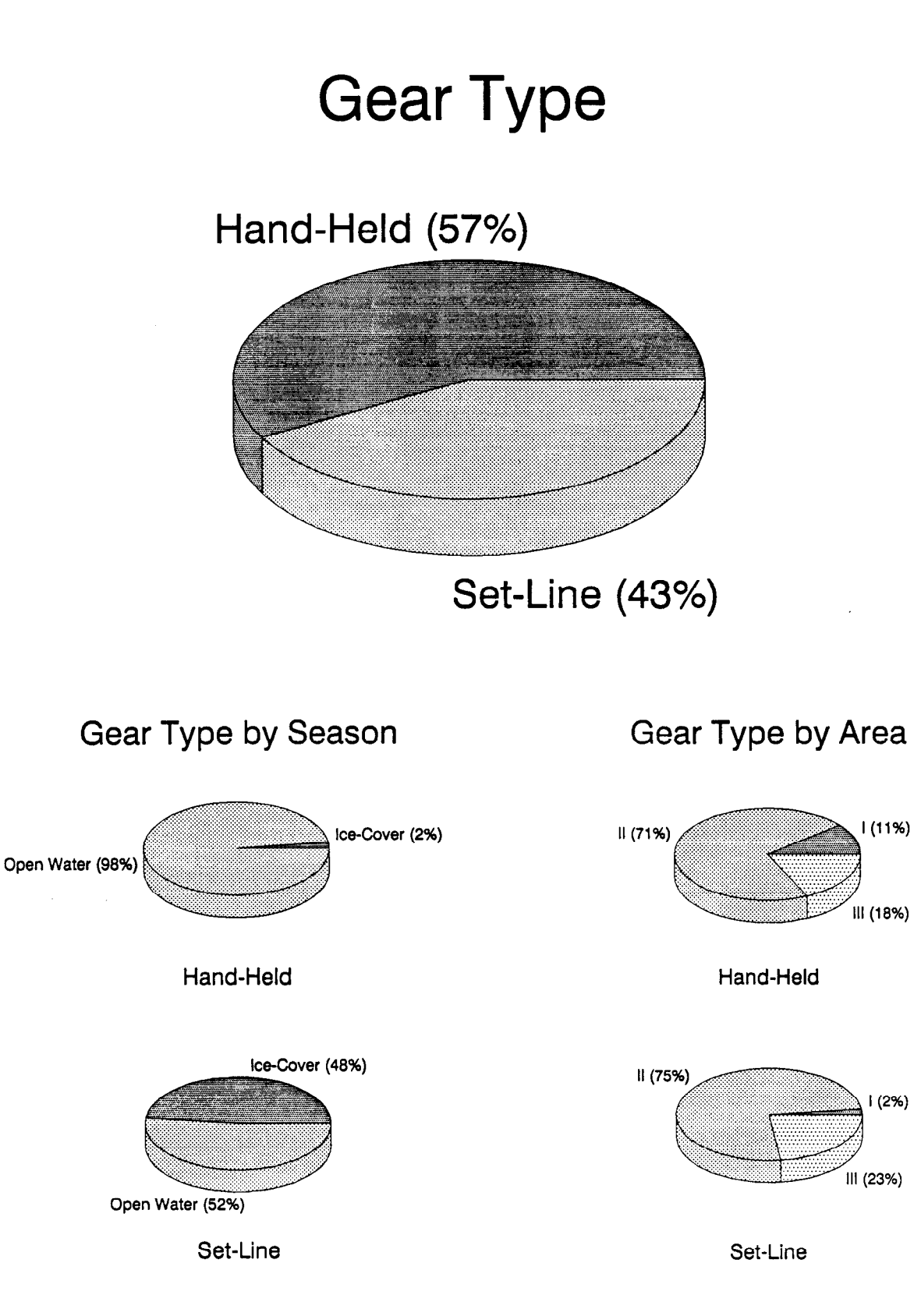


Figure 6. Proportions of harvest using hand-held lines and set-lines.

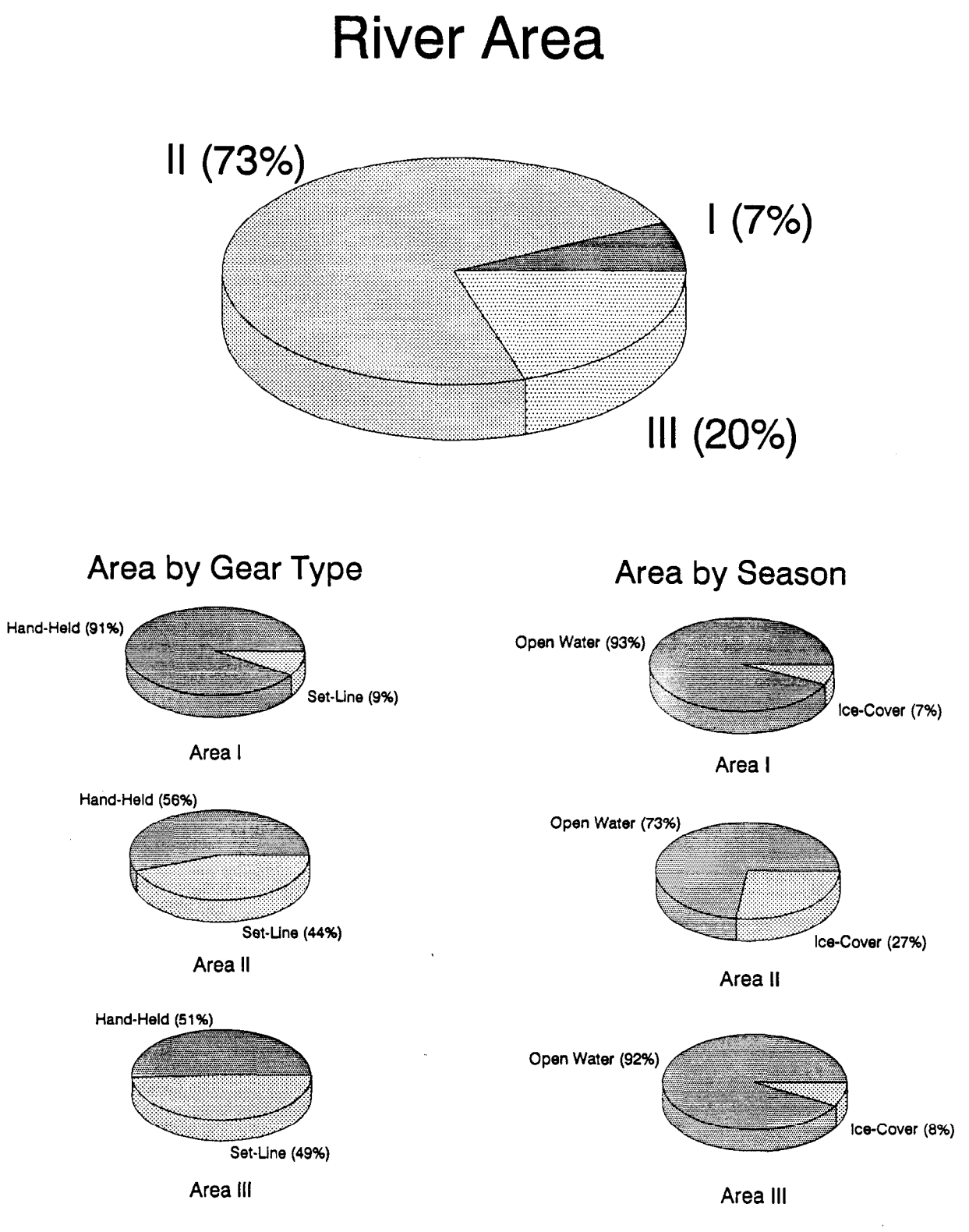


Figure 7. Proportions of harvest from three areas of the Tanana River drainage.

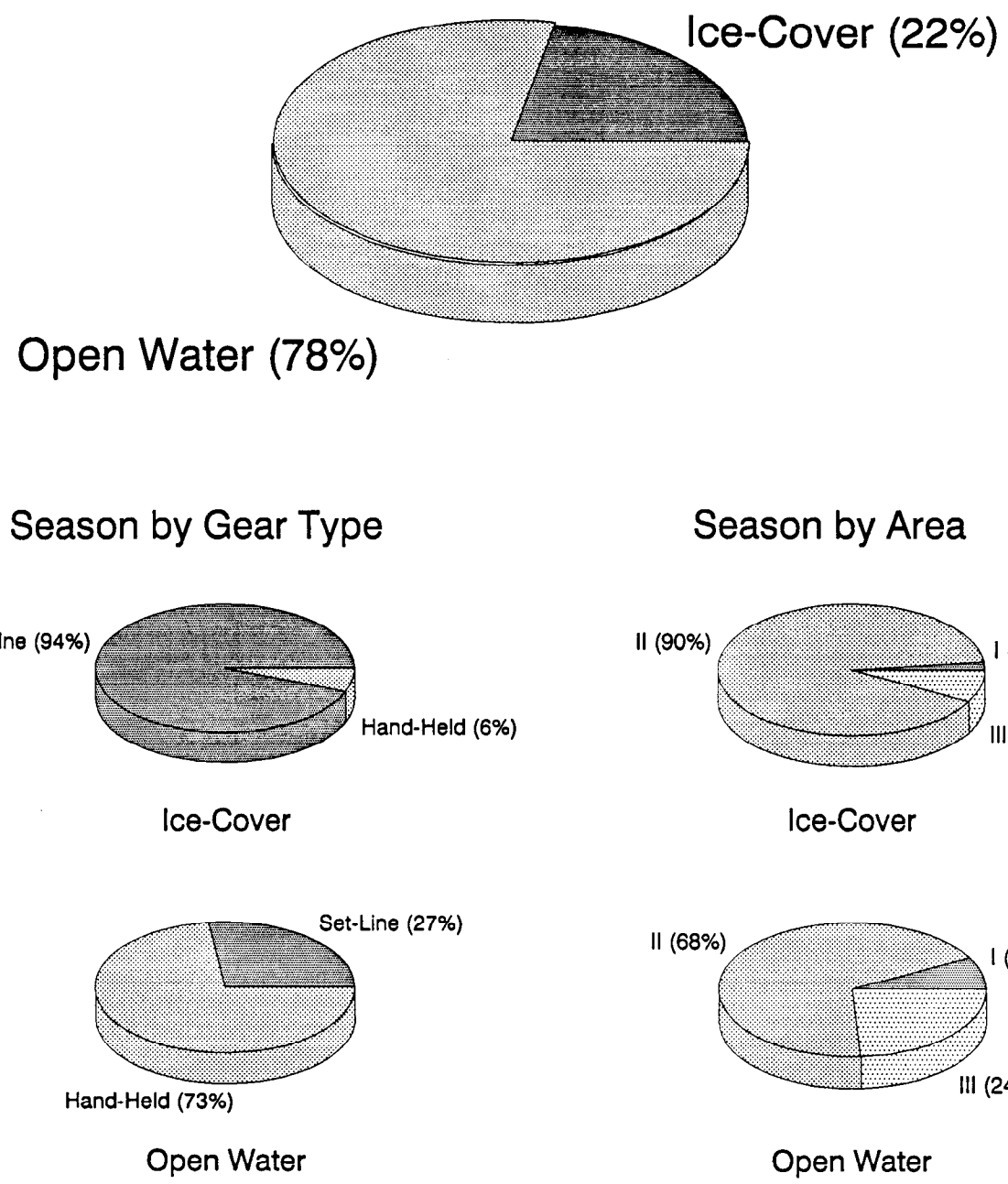


Figure 8. Proportions of harvest during periods of ice-cover and open water.

during open water than during ice-cover periods. The proportion of anglers using some (6-10) set-line hooks per day was higher during ice-cover periods than during open water periods (Table 5).

Proportions of Daily Catches

The estimates of proportions of daily catches are biased high. Thus, estimates for some and many burbot per day should be considered maximum estimates, while estimates for few burbot should be considered minimum estimates. The majority of anglers (69%) caught five burbot or less during one day of fishing. Anglers tended to catch few (1-5) burbot more often during ice-cover than during open water, and more often with set-lines than with hand-held lines. Conversely, anglers tended to catch six burbot or more per day more often using hand-held lines than using set-lines, and generally more often during open water than during ice-cover periods. Many burbot (11-15) were caught most frequently using set-lines during open water periods (Table 6).

DISCUSSION

When the estimates of harvest and effort from this survey are compared to those of the ASHS, it becomes apparent that this survey selected for those anglers who fished more often, caught more fish, and were more efficient. This can be attributed to the nonrandom manner in which our sample was obtained. Anglers who initially respond to the ASHS have a higher catch rate and fish more often than do anglers who respond after repeated mailings (Mills pers. comm.[2]). To compensate for this, a correction factor is applied based on the trend in responses from multiple mailings. No significant differences in responses were observed between the two mailings in this survey. This is most likely attributed to the fact that most of the respondents in this survey were anglers who were first-mailing respondents to the ASHS. Additionally, the smaller sample sizes in this study may not have detected this difference. While this survey is biased high for estimates of harvest (proportions of daily catches), the estimates of where, when and how the fish were caught are still considered valid. Because of the general questions on the ASHS regarding burbot harvest, only the estimate of proportional harvest by area could be tested. These proportions were nearly identical between the two surveys. It would be unlikely that how or when an angler fishes would affect response to either survey.

Participants in this survey were more effective anglers than those in the ASHS. They caught an average of 13 burbot per year using hand-held gear and 11 burbot per year using set-lines. Respondents from this survey caught more fish per hook than the average angler. A chi-square test of independence showed that the number of hooks used was independent of the number of days fished ($P = 0.43$). This indicates that anglers who fish more did not necessarily use more hooks.

Results of this survey have implications for other surveys of the participants in other fisheries. Although this survey was biased in terms of estimating harvest, it did survey a large portion of the burbot anglers in the Tanana

Table 5. Estimates of the proportions of all angler days in which few (1-5), some (6-10), and many (11-15) set-line hooks were used during both open-water and ice-cover seasons.

Number Hooks	Number of Respondents	Number of Days	Proportion	SE
		Ice Cover		
Few	21	105	0.427	0.101
Some	14	127	0.516	0.101
Many	3	14	0.057	0.035
		Open-Water		
Few	19	143	0.572	0.123
Some	12	72	0.288	0.106
Many	3	35	0.140	0.110
		Ice-Cover and Open-Water		
Few	40	248	0.500	0.085
Some	26	199	0.401	0.087
Many	6	49	0.099	0.059

Table 6. The proportions of daily catches in which few (1-5), some (6-10), and many (11-15) burbot were caught using both set-lines and hand-held lines during both open-water and ice-cover seasons.

Catch	Number of Respondents	Number of Days	Proportion	SE
Hand-Held Lines and Set-Lines				
		Ice-Cover		
Few	38	204	0.756	0.093
Some	7	37	0.137	0.067
Many	2	29	0.107	0.078
		Open-Water		
Few	95	597	0.672	0.057
Some	25	139	0.173	0.038
Many	12	137	0.154	0.046
		Ice-Cover and Open-Water		
Few	133	801	0.692	0.049
Some	32	191	0.165	0.033
Many	14	166	0.143	0.039
Set-Lines				
		Ice-Cover		
Few	29	178	0.739	0.102
Some	6	34	0.141	0.074
Many	2	29	0.120	0.087
		Open-Water		
Few	31	208	0.717	0.103
Some	4	30	0.103	0.050
Many	3	52	0.179	0.097
		Ice-Cover and Open-Water		
Few	60	386	0.727	0.074
Some	10	64	0.121	0.043
Many	5	81	0.153	0.067
Hand-Held Lines				
		Ice-Cover		
Few	9	26	0.897	0.104
Some	1	3	0.103	0.104
Many	0	0	0.000	0.000
		Open-Water		
Few	64	389	0.651	0.065
Some	21	124	0.207	0.047
Many	9	85	0.142	0.049
		Ice-Cover and Open-Water		
Few	73	415	0.662	0.062
Some	22	127	0.203	0.045
Many	9	85	0.136	0.047

River drainage with a small cost and time investment. If the objective of a survey is to obtain information from those anglers who participate the most and account for a large proportion of the total harvest, then this methodology may be preferred to a completely random survey.

Information from this survey shows that harvest will not be substantially reduced until daily bag limits are set to five burbot or less per day. At most, only 35% of the harvest with hand-held lines can be attributed to anglers catching more than five burbot per day (Table 6). As with hand-held lines, only a moderate fraction of the total harvest from set-lines can be attributed to anglers catching more than five burbot per day (Table 6). This also suggests that a reduction in daily bag limit to five burbot or less is needed to substantially reduce harvest. State-wide regulations (where set-lines are permitted) allow for the total aggregate number of set-line hooks to equal the daily bag limit. Although this study did not provide an estimate of mean catch per set-line hook fished, it did indicate that approximately half the set-line fishing effort was attributed to those anglers using six hooks or more per day. If catches are directly proportional to set-line effort, then a reduction in the daily allotment of set-line hooks to five per day or less could substantially reduce set-line harvest. A set-line restriction would be effective in river areas II and III, but would not substantially reduce harvest in river area I.

Regulatory changes in river areas I and III would be of little consequence in reducing total harvest. Within area II, harvests are essentially equal among the two gear types and substantial proportions of total harvest occur during both seasons (Figure 7; Table 4). A year-round reduction in daily bag limit in this area would be the most effective area restriction. This type of regulation may not reduce total harvest, but rather shift fishing effort to the other two river areas. This is not necessarily undesirable if the management concern is localized stock depletion in area II.

A seasonal closure, or a seasonal reduction in daily bag limit during the late-autumn, early-winter period (approximately 1 October through 1 January) might be an effective means of reducing harvest. This investigation indicated that more harvest occurs during open water than during ice-cover periods. During open water both gear types are used, although more burbot are harvested with hand-held lines than with set-lines. During ice-cover essentially all burbot are caught with set-lines (Figure 8). It has not been documented as to when harvest occurs within each of these seasons. Catch rates of burbot in hoop traps during open water periods are generally higher immediately after ice-out in Spring and just before freeze-up in Autumn than are catch rates during the summer months (Evenson 1991; Parker et al. 1987; 1988). This may also hold true for angled burbot. Through personal observation it appears that most of the ice-cover harvest in river area II occurs during the first two months following freeze-up in Autumn. During this time catch rates are high, ice cover is slight, and air temperatures are not yet extremely cold. Following this time lower catch rates, and extreme weather and ice conditions seem to reduce fishing effort.

ACKNOWLEDGEMENTS

We would like to thank the local burbot anglers who took the time to respond to the questionnaire; without their cooperation this research would not have been possible. Thanks to Mike Mills, Gary Fidler and other staff of the Research and Technical Services Section of the Anchorage office for providing names and addresses of fishermen, data entry and much valuable information from the Alaska State-wide Harvest Survey database. Thanks to regional staff of the Fairbanks office of Sport Fish Division for providing assistance with the preparation, packaging, and mailing of the survey. Thanks to David Bernard John Clark, and Peggy Merritt for their editorial comments. Thanks to Sara Case for the technical aspects of finalizing the report. The U.S. Fish and Wildlife Service provided partial funding of this project through the Federal Aid in Sport Fish Restoration Act.

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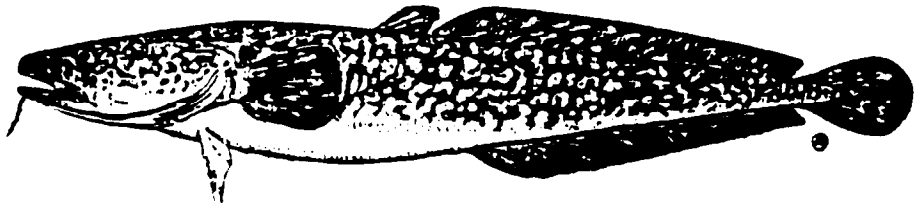
APPENDIX A

The questionnaire on burbot fishing in the Tanana River drainage.

BURBOT FISHING IN THE TANANA RIVER

QUESTIONNAIRE



INSTRUCTIONS

1) Please consider only the burbot fishing YOU did during 1990 (Jan 1 to Dec 31). If other members in your household fished for burbot during 1990, please instruct each addititonal burbot fisherman to complete one of the enclosed questionnaires. Please answer all questions to the best of your recollection.

2) All questions apply to the Tanana River and all it's tributary rivers and streams (does not include lakes and ponds).

3) Some questions inquire about the TOTAL NUMBER OF DAYS you fished. Even if you only fished for a short time on a given day, please count it as one day fished.

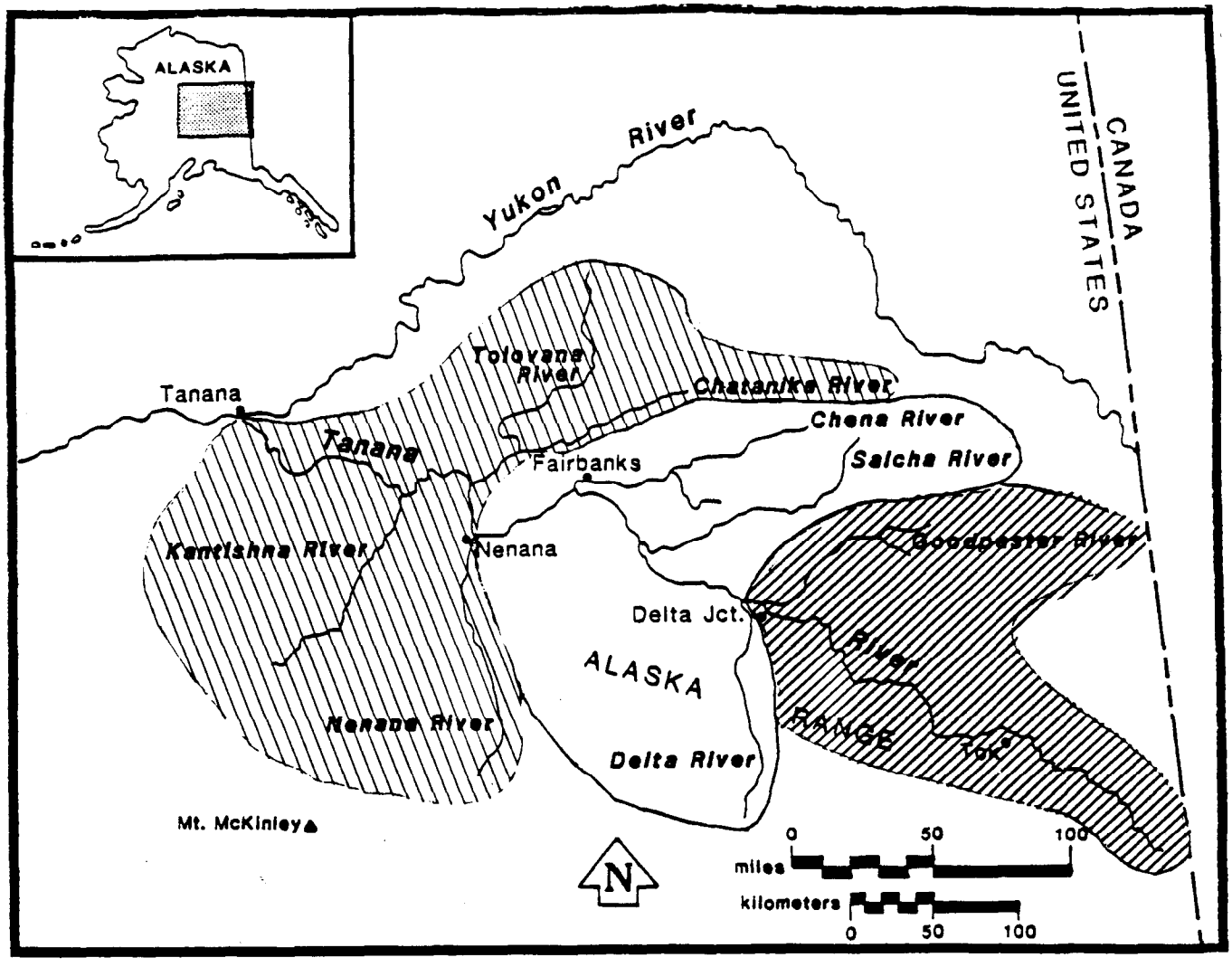
4) Some questions inquire about the TOTAL NUMBER OF BURBOT you caught. Please count only those burbot you caught and kept.

I fished for burbot in the Tanana River and/or it's tributaries during 1990:	YES	NO
	☐	☐

If your response was "YES" please continue the questionnaire.

If your response was "NO" please return the completed questionnaire.

PAGE (1)



AREA DESCRIPTIONS USED IN QUESTIONNAIRE

AREA I: The Tanana River and all it's tributary rivers and streams from it's confluence with the Yukon River upstream to and including the Nenana River

AREA II: The Tanana River and all it's tributary rivers and streams from the Nenana River upstream to and including the Delta River.

AREA III: The Tanana River and all it's tributary rivers and streams from the Delta River upstream to and including the Chisana and Nabesna Rivers.

PAGE (2)

PART I HAND-HELD LINES (ROD AND REEL)

		YES	NO
1)	During 1990 did you fish for burbot using HAND-HELD LINES (Rod and Reel) ?	☐	☐

If your response to this question was "YES" please continue the questionnaire with question #2

If your response to this question was "NO" please continue the questionnaire with PART II (question #6)

2) The TOTAL NUMBER OF DAYS You fished for burbot during 1990 using HAND-HELD LINES (Rod and Reel) was: ☐

3) The TOTAL NUMBER OF BURBOT you caught during 1990 using HAND-HELD LINES (Rod and Reel) was: ☐

4) Please use your responses from questions #2 and #3 to complete the following table. The river area descriptions are shown on the map on page 2. Please consider only the fishing you did in 1990 using hand-held lines (rod and reel).

	AREA I LOWER RIVER		AREA II MIDDLE RIVER		AREA III UPPER RIVER	
	TOTAL # OF DAYS FISHED	TOTAL # OF BURBOT CAUGHT	TOTAL # OF DAYS FISHED	TOTAL # OF BURBOT CAUGHT	TOTAL # OF DAYS FISHED	TOTAL # OF BURBOT CAUGHT
ICE COVER						
OPEN WATER						

5) Please consider your response to question #2 and fill in the appropriate boxes for the TOTAL NUMBER OF DAYS you caught 0-5, 6-10, and 11-15 burbot during open water and during ice cover. Please consider only the fishing you did in 1990 using hand-held lines (rod and reel).

NUMBER OF BURBOT CAUGHT	OPEN WATER TOTAL # OF DAYS	ICE COVER TOTAL # OF DAYS
0 to 5		
6 to 10		
11 to 15		

PAGE (4)

PART II SET-LINES

6) During 1990 did you fish for burbot using using SET-LINES ?

YES	NO

If your response to this question was "YES" please continue the questionnaire with question #7.

If your response to this question was "NO" please continue the questionnaire with PART III (question #12).

7) The TOTAL NUMBER OF DAYS You fished for burbot during 1990 using SET-LINES was: ☐

8) The TOTAL NUMBER OF BURBOT you caught during 1990 using SET-LINES was: ☐

9) Please use your responses from questions #7 and #8 to complete the following table. The river area descriptions are shown on the map on page 2. Please consider only the fishing you did in 1990 using SET-LINES.

	AREA I LOWER RIVER		AREA II MIDDLE RIVER		AREA III UPPER RIVER	
	TOTAL # OF DAYS FISHED	TOTAL # OF BURBOT CAUGHT	TOTAL # OF DAYS FISHED	TOTAL # OF BURBOT CAUGHT	TOTAL # OF DAYS FISHED	TOTAL # OF BURBOT CAUGHT
ICE COVER						
OPEN WATER						

10) Please consider your response to question *7 and fill in the appropriate boxes for the TOTAL NUMBER OF DAYS you caught 0-5, 6-10, and 11-15 burbot during open water and during ice cover. Please consider only the fishing you did in 1990 using SET-LINES.

Number of BURBOT Caught	Open Water TOTAL # OF DAYS	Ice Cover TOTAL # OF DAYS
0 to 5		
6 to 10		
11 to 15		

11) Please consider your response to question *7 and fill in the appropriate boxes for the TOTAL NUMBER OF DAYS you fished using 0-5, 6-10, and 11-15 SET-LINE HOOKS during open water and during ice cover. Please consider only the fishing you did in 1990.

Number Of SET-LINE HOOKS	Open Water TOTAL # OF DAYS	Ice Cover TOTAL # OF DAYS
0 to 5		
6 to 10		
11 to 15		

PAGE (6)

PART III GENERAL QUESTIONS

12) How many miles (round trip) did you travel per fishing trip during 1990? If you went to different areas, please indicate the number of times and the round trip mileage you travelled to each area.

HAND-HELD LINES (ROD & REEL)	# of trips	round trip mileage per trip	SET-LINES	# of trips	round trip mileage per trip
AREA "A"	☐	☐	AREA "A"	☐	☐
AREA "B"	☐	☐	AREA "B"	☐	☐
AREA "C"	☐	☐	AREA "C"	☐	☐
AREA "D"	☐	☐	AREA "D"	☐	☐

13) If your fishing success was greater, would you take more trips each year? YES ☐ NO ☐

If you answered "YES", about how many more trips per year would you take than you normally take at your present catch rates? ☐

14) If you could catch bigger burbot per fishing trip, but the total number of burbot you could catch was decreased, would you take more trips? YES ☐ NO ☐

If you answered "YES", about how many more trips per year would you take than you normally take at your present catch rates? ☐

15) Once you arrived at a fishing area, how many hours did you usually spend fishing per trip?

ICE COVER ☐ OPEN WATER ☐

16) How do you rate the overall quality of burbot fishing in the Tanana River?

EXCELLENT ☐ GOOD ☐ FAIR ☐ POOR ☐

PAGE (7)

17) If access to the fishery was improved, for example by snowplowing an existing road in winter, or clearcutting a trail from an existing road to the river, would you take more (burbot) fishing trips? YES ☐ NO ☐

If you answered "YES", about how many more trips per year would you take? ☐

What specific recommendations regarding access improvement do you have?

_____

_____

_____

18) Are you satisfied with existing regulations concerning burbot fishing in the Tanana River system? YES ☐ NO ☐

If you answered "NO", what specific recommendations regarding regulation changes do you have?

_____

_____

_____

_____

APPENDIX B

Cover letters sent with the postal questionnaire.

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

WALTER J. HICKEL, GOVERNOR

1300 COLLEGE ROAD
FAIRBANKS, ALASKA 99701-1599

Dear Alaskan Angler:

The Alaska Department of Fish and Game, Division of Sport Fish is conducting research on burbot fishing in the Tanana River and its tributaries. The purpose of this study is to determine how, when, and where burbot are caught throughout this large river system. Your name has been randomly selected from a list of anglers who responded to the Alaska Department of Fish and Game Statewide Sport Fish Harvest Survey as having fished for burbot in the Tanana River system at some time during the past six years.

The attached questionnaire inquires about all burbot fishing you did during 1990 (Jan. 1 - Dec. 31) in the Tanana River and its tributaries. Even if you fished very little or not at all during 1990, your answers are important in making the survey accurate and complete. Please take a few minutes to complete this questionnaire. Your individual answers will remain confidential. Only summary results will be made public.

If you have any questions or comments concerning this survey, please contact me. Thank you for your help.

Sincerely,

Matt Evenson

Matt Evenson
Fishery Biologist
Sport Fish Division
(907) 456-8819

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

WALTER J. HICKEL, GOVERNOR

1300 COLLEGE ROAD
FAIRBANKS, ALASKA 99701-1599

Dear Alaskan Angler,

We have not yet received your completed questionnaire on burbot fishing in the Tanana River. Even if you fished very little or not at all for burbot during 1990, your responses to this survey are important in making our results accurate. Would you please take a few minutes to answer the questionnaire.

If you have already returned your questionnaire, please disregard this letter and accept our thanks.

Sincerely,

Matt Evenson

Matt Evenson
Fishery Biologist
Sport Fish Division
(907) 456-8819

APPENDIX C

Appendix C1. Comparisons of upper and lower 95% confidence intervals (U95 and L95) of proportion estimates from the postal questionnaire between two separate mailings.

Mailing	Parameter	Proportion	Variance	L95	U95
FIRST	Area I	0.04	0.00	0.00	0.08
SECOND	Area I	0.13	0.01	-0.06	0.33
FIRST	Area II	0.80	0.00	0.69	0.91
SECOND	Area II	0.55	0.02	0.27	0.84
FIRST	Area III	0.16	0.00	0.05	0.26
SECOND	Area III	0.31	0.02	0.05	0.57
FIRST	Ice-Cover/Few Days/Hand-Held Lines	0.67	0.01	0.43	0.90
SECOND	Ice-Cover/Few Days/Hand-Held Lines	0.95	0.00	0.87	1.03
FIRST	Ice-Cover/Many Days/Hand-Held Lines	0.16	0.01	-0.06	0.37
SECOND	Ice-Cover/Many Days/Hand-Held Lines	0.00	0.00	0.00	0.00
FIRST	Ice-Cover/Some Days/Hand-Held Lines	0.18	0.01	-0.00	0.36
SECOND	Ice-Cover/Some Days/Hand-Held Lines	0.05	0.00	-0.03	0.13
FIRST	Open-Water/Few Days/Hand-Held Lines	0.74	0.00	0.62	0.86
SECOND	Open-Water/Few Days/Hand-Held Lines	0.46	0.01	0.24	0.69
FIRST	Open-Water/Many Days/Hand-Held Lines	0.07	0.00	0.02	0.13
SECOND	Open-Water/Many Days/Hand-Held Lines	0.41	0.02	0.16	0.66
FIRST	Open-Water/Some Days/Hand-Held Lines	0.19	0.00	0.10	0.28
SECOND	Open-Water/Some Days/Hand-Held Lines	0.13	0.00	0.01	0.24
FIRST	Hand-Held Lines	0.60	0.00	0.48	0.72
SECOND	Hand-Held Lines	0.52	0.02	0.26	0.77
FIRST	Ice-Cover/Few Days/Set-Lines	0.51	0.02	0.27	0.76
SECOND	Ice-Cover/Few Days/Set-Lines	0.25	0.02	-0.04	0.54
FIRST	Ice-Cover/Many Days/Set-Lines	0.08	0.00	-0.01	0.18
SECOND	Ice-Cover/Many Days/Set-Lines	0.00	0.00	0.00	0.00
FIRST	Ice-Cover/Some Days/Set-Lines	0.40	0.01	0.17	0.64
SECOND	Ice-Cover/Some Days/Set-Lines	0.75	0.02	0.46	1.04
FIRST	Open-Water/Few Days/Set-Lines	0.62	0.02	0.37	0.88
SECOND	Open-Water/Few Days/Set-Lines	0.43	0.08	-0.11	0.97

-continued-

Appendix C1. (Page 2 of 2).

Mailing	Parameter	Proportion	Variance	L95	U95
FIRST	Open-Water/Many Days/Set-Lines	0.03	0.00	-0.01	0.07
SECOND	Open-Water/Many Days/Set-Lines	0.46	0.09	-0.14	1.06
FIRST	Open-Water/Some Days/Set-Line	0.35	0.02	0.10	0.61
SECOND	Open-Water/Some Days/Set-Lins	0.11	0.01	-0.08	0.30
FIRST	Ice-Cover	0.20	0.00	0.09	0.31
SECOND	Ice-Cover	0.26	0.01	0.05	0.46
FIRST	Open-Water	0.80	0.00	0.69	0.91
SECOND	Open-Water	0.74	0.01	0.54	0.95
FIRST	Set-Line	0.40	0.00	0.28	0.52
SECOND	Set-Line	0.48	0.02	0.23	0.74

Appendix C2. Comparisons of upper and lower 95% confidence intervals (U95 and L95) of proportion estimates from the postal questionnaire among three mailing groups.

Mailing Source	Parameter	Proportion	Variance	L95	U95
ADFG[a]	Area I	0.04	0.00	-0.05	0.13
ASHS[b]	Area I	0.12	0.00	-0.01	0.26
Sport F.[c]	Area I	0.03	0.00	-0.01	0.06
ADFG	Area II	0.73	0.02	0.46	0.99
ASHS	Area II	0.74	0.01	0.59	0.89
Sport F.	Area II	0.72	0.01	0.50	0.94
ADFG	Area III	0.23	0.02	-0.02	0.48
ASHS	Area III	0.13	0.00	0.04	0.23
Sport F.	Area III	0.26	0.01	0.04	0.47
ADFG	Ice-Cover/Few Days/Hand-Held Lines	1.00	0.00	1.00	1.00
ASHS	Ice-Cover/Few Days/Hand-Held Lines	0.79	0.02	0.50	1.07
Sport F.	Ice-Cover/Few Days/Hand-Held Lines	0.67	0.02	0.39	0.96
ADFG	Ice-Cover/Many Days/Hand-Held Lines	0.00	0.00	0.00	0.00
ASHS	Ice-Cover/Many Days/Hand-Held Lines	0.00	0.00	0.00	0.00
Sport F.	Ice-Cover/Many Days/Hand-Held Lines	0.21	0.02	-0.07	0.49
ADFG	Ice-Cover/Some Days/Hand-Held Lines	0.00	0.00	0.00	0.00
ASHS	Ice-Cover/Some Days/Hand-Held Lines	0.21	0.02	-0.07	0.50
Sport F.	Ice-Cover/Some Days/Hand-Held Lines	0.12	0.01	-0.04	0.28
ADFG	Open-Water/Few Days/Hand-Held Lines	0.81	0.02	0.56	1.07
ASHS	Open-Water/Few Days/Hand-Held Lines	0.66	0.01	0.51	0.81
Sport F.	Open-Water/Few Days/Hand-Held Lines	0.65	0.01	0.45	0.84
ADFG	Open-Water/Many Days/Hand-Held Lines	0.00	0.00	0.00	0.00
ASHS	Open-Water/Many Days/Hand-Held Lines	0.13	0.00	0.01	0.24
Sport F.	Open-Water/Many Days/Hand-Held Lines	0.22	0.01	0.05	0.38
ADFG	Open-Water/Some Days/Hand-Held Lines	0.19	0.02	-0.07	0.44
ASHS	Open-Water/Some Days/Hand-Held Lines	0.21	0.00	0.09	0.33
Sport F.	Open-Water/Some Days/Hand-Held Lines	0.14	0.00	0.03	0.24
ADFG	Hand-Held Lines	0.70	0.01	0.50	0.91
ASHS	Hand-Held Lines	0.71	0.01	0.56	0.85
Sport F.	Hand-Held Lines	0.41	0.01	0.24	0.58

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Appendix C2. (Page 2 of 2).

Mailing Source	Parameter	Proportion	Variance	L95	U95
ADFG	Ice-Cover/Few Days/Set-Lines	0.45	0.04	0.07	0.83
ASHS	Ice-Cover/Few Days/Set-Lines	0.37	0.03	0.00	0.73
Sport F.	Ice-Cover/Few Days/Set-Lines	0.46	0.02	0.18	0.74
ADFG	Ice-Cover/Many Days/Set-Lines	0.00	0.00	0.00	0.00
ASHS	Ice-Cover/Many Days/Set-Lines	0.05	0.00	-0.06	0.15
Sport F.	Ice-Cover/Many Days/Set-Lines	0.08	0.00	-0.04	0.19
ADFG	Ice-Cover/Some Days/Set-Lines	0.55	0.04	0.17	0.93
ASHS	Ice-Cover/Some Days/Set-Lines	0.59	0.04	0.21	0.96
Sport F.	Ice-Cover/Some Days/Set-Lines	0.46	0.02	0.18	0.74
ADFG	Open-Water/Few Days/Set-Lines	0.71	0.02	0.44	0.98
ASHS	Open-Water/Few Days/Set-Lines	0.40	0.04	0.02	0.79
Sport F.	Open-Water/Few Days/Set-Lines	0.61	0.03	0.26	0.96
ADFG	Open-Water/Many Days/Set-Lines	0.00	0.00	0.00	0.00
ASHS	Open-Water/Many Days/Set-Lines	0.08	0.00	-0.05	0.21
Sport F.	Open-Water/Many Days/Set-Lines	0.19	0.03	-0.15	0.53
ADFG	Open-Water/Some Days/Set-Line	0.29	0.02	0.02	0.56
ASHS	Open-Water/Some Days/Set-Lins	0.52	0.05	0.10	0.93
Sport F.	Open-Water/Some Days/Set-Lies	0.20	0.02	-0.05	0.44
ADFG	Ice-Cover	0.08	0.00	0.00	0.16
ASHS	Ice-Cover	0.22	0.00	0.08	0.35
Sport F.	Ice-Cover	0.26	0.01	0.08	0.44
ADFG	Open-Water	0.92	0.00	0.84	1.00
ASHS	Open-Water	0.78	0.00	0.65	0.92
Sport F.	Open-Water	0.74	0.01	0.56	0.92
ADFG	Set-Line	0.30	0.01	0.09	0.50
ASHS	Set-Line	0.29	0.01	0.15	0.44
Sport F.	Set-Line	0.59	0.01	0.42	0.76

[a] ADFG = Alaska Department of Fish and Game
[b] ASHS = Alaska Statewide Harvest Survey
[c] Sport F. = Sport Fishermen